THE PRINIPLES UNDERLYING THE SAFE AND MORE RAPID EVOLUTION OF THORACIC SURGERY[1]

By Willy Meyer, M.D.,
NEW YORK.

Mr. President, Ladies and Gentlemen:

While a dozen years ordinarily may represent an age in our times, they mean hardly more than a few months in medical science; and so, I hope, you will understand when I frankly state that, though I have all of eleven years to my credit in active clinical work as well as in the study of the literature on the subject, I consider myself no more than a mere tyro in thoracic surgery.

It took abdominal surgery fully forty years to develop to its splendid status, no small part of which was accomplished right here in Rochester. Nevertheless, every day, one might say, sees the great edifice of our abdominal work enlarged by some addition. It is true that thoracic surgery had the benefit of all the experiences gained in abdominal surgery as well as the additional asset of having started with a most perfect asepsis. But in spite of all this I hardly think we shall go much amiss in predicting that there will still remain problems to solve for our children and children's children.

Attention should be called briefly to the principal practical differences between abdominal and thoracic surgery. When we make an incision to reach a diseased organ within the abdominal cavity, *e. g.*, stomach, liver, appendix or what else it may be, if the anesthetist is efficient, the asepsis faultless, and we know how to do the required work, the majority of our patients recover. In the interval operation for appendicitis, for instance, we see of 100 patients 100 get well. When we cut into the abdomen, having divided the wall of this cavity and also the outer layer of the sac, which we call peritoneum, its contents lie before us in their anatomical relation as well as remain undisturbed until we disturb them; the respiration and the circulation of the blood, too, continue without disturbance. With perfect ease and equanimity we can go about our task. But in thoracic surgery the matter is not quite so simple. Granted the same perfection in every technical detail as before, every time a thorax is opened "something" happens that does not happen when the abdominal cavity is opened. It announces itself by a hissing sound. What is this something?

When we make an incision between two ribs, carefully separating layer after layer of muscular tissue, and at last also dividing the septum which we call the pleura, we open thereby the pleural sac

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which protects the lung. Under normal conditions the lung completely fills the space between mediastinum and chest wall, and the pleural sac surrounding it contains neither air nor fluid, excepting only a small amount of viscid, glue-like substance that permits the leaves of the pleura, the one covering the wall of the chest, mediastinum and diaphragm, the other covering the lung, to glide upon one another without perceptible friction, as two panes of glass do when there is a film of water between them. We have, then, under physiological conditions no air on the outside of the lung, but on the inside of the lung we find the pressure of the atmosphere, and this pressure keeps the elastic fibers, of which the lung tissue is largely built up, distended. This condition is changed through our incision which, being made for operative purposes, is usually a large one. The air has now free access to the space from which nature had it carefully excluded, and it is then that this "something" happens to which I have previously alluded: the large, freely expanding and contracting organ, the lung, that we had met upon opening the chest, suddenly leaves the inner chest wall, loses its contact with it and before our eyes becomes smaller and smaller until, no larger than a man's fist, it comes to rest near the spinal column. It has been put out of commission. The collapsed lobes no longer take part in the function of the lung of ventilating the blood, feeding it with oxygen and freeing it of the excess of carbon dioxide, and the space previously filled with the lung has become a large, empty cavity. Why does all this happen? It is due to the equalizing of air-pressure upon the inside and upon the outside of the lung. The one-sided air-pressure upon the inside only, which, as explained, kept the elastic fibers distended, being now counteracted by the equally great air-pressure admitted through our incision to the outside of the lung, leaves the contractile strength of the elastic fibers as the only active force present, and, unless the lung should happen to be adherent to the chest wall, it contracts down upon its pedicle, the bronchial tube, which enters it near the bifurcation of the trachea.

But that is not all. This is only what immediately follows the hissing noise of which I told you before. Something else happens. The thoracic cavity is divided in the center by a structure reaching from spine to sternum, which we call the mediastinum, with lung to the right and to the left of it, and in which are located the heart, the large bloodvessels connecting heart and lung, nerves and other soft tissues. From mere enumeration of these parts as the very seat of life itself, you will understand the importance of their being left undisturbed in their various functions. That, however, is just what is not the case after one side of the lung has collapsed. The patient makes strenuous efforts at breathing with the closed side of the lung and thereby sets the mediastinum in motion to the right and to the left, like a sail flops in a head-on breeze, which, like the mediastinum,

is fixed above and below. This to-and-fro motion of the mediastinum interferes with the proper ventilation of the still functionating part of the lung, and thus, though only one side is opened to the outer air, nevertheless both sides of the lung are injuriously affected. All this occurs only if the tissues within the chest are in their virgin condition. If in consequence of inflammation or other causes the soft mediastinal structures have become harder and more resistant it does not take place.

The condition just described is called pneumothorax, from the Greek "pneuma"=air, the term meaning: air in the thorax; it is unilateral or bilateral, according as to whether the outer air has direct access to one or both sides of the lung. The bilateral pneumothorax, unless promptly corrected, is always fatal; the unilateral is not always that. It seems that about 40 to 50 per cent. of patients are able to stand a unilateral pneumothorax; but, unfortunately, we have no means of knowing beforehand whom we may include in and whom we must exclude from this percentage. It is the same as in appendicitis, where the great majority of patients who have had one attack will have another sooner or later of which they may die. We cannot possibly know beforehand who will and who will not have a recurrence, therefore the rule that the inflamed appendix must be removed in every case, either during or soon after the first attack. It is a wise precaution. Along the same line of reasoning, if we know of a method to forestall pneumothorax, unilateral or bilateral, should we not apply it, thereby increasing the patient's chances of recovery? Surely, and more than that, it is our duty to do so. This method exists. This method consists in the use of apparatus designed to prevent the described effects of the inrush of air into the pleural cavity upon incision for operative purposes, and the general conditions here outlined as prevailing during the operation constitute the first principal difference between thoracic and abdominal surgery.

We now turn to the second principal difference between these two branches of surgery and find the same to pertain to conditions after the operation—to the after-treatment. Peritoneum as well as pleura tend to form adhesions after the operative wound has been closed, but the pleura has an additional tendency which the peritoneum has not equally outspoken. The pleura, being more sensitive to traumatism, discharges into the pleural cavity a fluid which we call an "exudate." Despite the most rigid asepsis this exudate does not always remain sterile, nor is it always absorbed. It may require drainage later on and may give rise to serious complications. A casual observer may here say: "Why not drain from the corner of the wound when closing up," or "Why not close the wound completely and drain through a lateral stab?" One thus arguing overlooks the air that would filter in alongside the tube, producing an "acute postoperative pneumothorax," which is no less

dangerous and often has the same fatal consequences as the above described acute operative pneumothorax.

Again I ask, would it not be a great step in advance if the danger of the postoperative pneumothorax could also be forestalled? If we could close up the thorax air-tight after the operation and yet drain? And this is the second point I want to bring out: We are able to do this. A method of air-tight drainage has been evolved which is safe and reliable and eliminates, barring an unforeseen accident, the danger of the occurrence of a postoperative pneumothorax.

I should be happy had I succeeded in holding your attention until now, but in the balance of my address I shall have to become more technical and address myself more to the medical men who good-naturedly have permitted me to explain to the ladies what to them is a matter of general knowledge.

I propose now to take up and discuss the two points before developed, *viz.*, the prevention of the acute pneumothorax (collapse of the lung), during the operation and the prevention of the acute pneumothorax during drainage after the operation.

1. **Avoidance of the Acute Operative Pneumothorax.** The construction and use of apparatus for thoracic operations began in the middle of the 90's of the last century, when Quénu, of Paris, worked out an apparatus on the lines of a diver's helmet, in which the patient's head was placed under increased air-pressure together with a sponge saturated with chloroform. Tuffier, of Paris, soon after advocated and practised the use of insufflation of air into the trachea. They tested their suggestions by animal experiments which one of them, at least, followed up with thoracic operations on the human subject in the hospitals of Paris, avoiding the effects of an acute pneumothorax.

America, above all, has a right to be proud of the pioneer work she has rendered in this field. I am referring to the valve apparatus for artificial respiration worked out by Fell and to the pump apparatus constructed by Matas, of New Orleans, both designed on the basis of the O'Dwyer tube. In 1898, Parham, of New Orleans, made use of Matas's apparatus in a resection of the chest wall for tumor, the first recorded thoracic operation under differential pressure in this country. His patient recovered.

However, this case and similar ones remained isolated. They were interesting cases, and there it ended. More concerted action resulted when the differential pressure idea was conceived anew by F. Sauerbruch in 1903. He had been charged by his chief, the late Prof. v. Mickulicz, of Breslau, to find a method which would make work in the thorax as safe as that in other cavities of the body. The construction of Sauerbruch's negative chamber in the following year was the result of this work. Thus the year 1904 marks the real beginning of thoracic surgery by the transpleural route. The

apparatus designed for experimental work consisted of a box with the animal's head outside and the chest and body inside. A cut-out with rubber collar in one of the sides of the rectangular box served for the passage of the neck of the animal, surgeon and assistant sitting inside the box. The air-pressure in the box was reduced by machinery to a degree equalizing the force of the physiological force of contraction of the normal elastic lung tissue. This having been done, transpleural incisions could be made in the intercostal spaces right and left, or large flaps of the chest wall be raised, the animal continuing meanwhile to breathe as if nothing had happened. Upon reversing conditions the animal's head being put into the box and the body outside and the air-pressure within the box being increased, the same phenomenon, *i. e.*, non-collapse of the lung, was observed when the thorax was opened and the animal breathed the increased pressure.

On the basis of the artificial reduction of the air-pressure within the chamber below the normal atmospheric pressure, considering the latter as zero-pressure, this operative procedure was called "operation under negative pressure." The method as such was termed "operating under difference in air-pressure," or, briefly, "under differential pressure." In 1904 a large chamber, made of iron and glass, for operations on man was in use at Breslau.

Four years later an amplified type, constructed on the basis of Sauerbruch's principles, was built in New York and is now a part of the instrumentarium of the Thoracic Pavilion of the Lenox Hill Hospital of New York City. It is the only one in America.

The negative chamber represents an enlarged pleural cavity and is the most "physiological" apparatus in existence for complicated intrathoracic work upon weak and reduced patients. It permits of the use of differential pressure under general as well as local anesthesia. It is a splendid physical apparatus and will forever retain its scientific as well as its practical value. But the negative chamber is expensive and stationary, surgeon, assistants, nurses and patient have to go to the apparatus; the apparatus cannot be brought to the patient.

For this and other reasons the attention of the surgical world turned more to the positive differential pressure method, as first represented by the positive cabinet and its modifications. In quick succession three additional, useful procedures of employing positive air-pressure have been perfected: The mask method (1908); intratracheal insufflation (1910) and pharyngeal insufflation (1913). In each of them the lung is blown up artificially in order to overcome the pressure upon the outside of the lung of the atmospheric air, which communicates with the interior of the pleural sac by way of the incision.

The employment of any one of the four methods mentioned enables us to avoid the collapse of the lung on incising the pleural

cavity when adhesions between lung surface and chest wall are not present. In other words, any one of these four methods enables us to avoid the occurrence of the acute pneumothorax with its sequelæ and, therefore, makes work in the thorax perfectly safe.

In 1914 the opposition originally aroused by the differential pressure method as employed in thoracic operations had almost ceased. The method was recognized as safe for operative work within the chest by the great majority of colleagues interested in this branch of work.

In 1914 the war broke out and with it came a recrudescence f opposition.

Personally, I am fond of opposition, because opposition stimulates discussion and discussion is the foundation of progress. It was principally for the purpose of free discussion that the "American Association for Thoracic Surgery" was founded three years ago. But opposition must be constructive and not destructive. In this particular instance the opposition, to my mind, is decidedly destructive.

When the war came many of the men who went overseas were suddenly confronted with important traumatic chest cases and were compelled to do chest surgery without previous practical experience in this line. After temporizing for a time, they became aggressive, opened the injured chest widely, did the required work as in other parts of the body, closing the thorax as they were accustomed to closing the abdomen and saw splendid results, though no differential pressure apparatus had been used. No wonder they became enthusiastic and soon proclaimed: "There is no fundamental difference between operation within the abdominal and thoracic cavities; differential pressure is an unnecessary ballast; we can well get along without it." And, in order to carry his point, one renowned colleague even suggests the division of thoracic surgery into different chapters, requiring different types of operation, *e. g.*, lung surgery and esophageal surgery.

How can we explain the discrepancy between the experience in thoracic operations at or near the front and as seen in peace practice at home?

It has been stated on the basis of investigations made during the war that 50 per cent. or more of the patients with penetrating chest wounds died on the battle field. Those who reached a hospital behind the lines were the ones who had not succumbed to the effect of the acute pneumothorax and hemothorax, *viz.*, the sudden entrance of air plus blood into the chest. Let us remember, further, that these soldiers were young men in the prime of life, who had not been sick for months and years, as is the case with the majority of patients whom we are called upon to treat for thoracic disease in times of peace. On these young and strong men, who had survived all the immediate consequences of the injury of the chest, our colleagues

who were abroad were called upon to operate; on these they gathered their experience. Under aseptic precautions they made an incision of the required length—and the long chest wound usually is better for the wounded than a small one, which latter often permits air to enter the chest, but not to leave it readily—pulled the lung forward and held it in front of the wound for the necessary work. The mediastinum now could not flop from one side to the other, the well-known method to avoid the development of the symptoms of the acute pneumothorax (Müller's trick). The mediastinum is thus steadied during the operation and the lung is attended to as the case may require and then dropped back. If the chest was closed air-tight the great majority of patients had a good chance of recovery and were seen to recover.

With this impression in mind, renowned medical men have come from England, France and Italy in the course of the last three years to visit us. They have travelled through our country and have given us the results of their personal experiences. Some of them had been carried away by the favorable results obtained in traumatic chest surgery, done without any apparatus, on soldiers who had survived the shock and the effect of acute pneumo- and hemothorax, done while the soldiers were still suffering from them, and they wondered why any surgeon had ever thought it necessary to make special provision for an interference in the interior of the chest.

I have the greatest admiration for their medical courage, to take up under such adverse circumstances a new line of operative work and, what is more, make a success of it. All honor to them!

On the other hand, I cannot help asking is it right to draw such sweeping conclusions from the experience in one small part of the surgery of the chest—the traumatic—with reference to thoracic surgery in its entirety? To my mind it is not permissible.

To show how discussion helps in clearing up a fundamental question like the one we are considering allow me to cite a personal experience: When the commission of surgeons from the front, consisting of three representatives from England, one from France and one from Italy, came to attend the American Congress of Surgeons in October, 1918, they visited the Lenox Hill Hospital of New York City and looked over the thoracic apparatus there installed. After a heart-to-heart talk of almost two hours on the means at hand today, to avoid or overcome the acute pneumothorax in chest operations, three of the five gentlemen joined me in the stand: that we do need the differential pressure method for safe operating within the thorax.

I most fervently hope that those colleagues who still think differently, because they have had favorable experiences in chest surgery without the employment of apparatus, will come forward and relate their observations. If their charts prove that the work can be done equally well and equally safely for the patient, without

apparatus, why should we trouble ourselves with differential pressure methods? why should we not throw all apparatus overboard and proceed as in other parts of the body? I for one still believe that if we had one hundred patients with surgical chest disease and gave fifty cases each to two surgeons who commanded equally good technic and perfect asepsis, one working with apparatus and maintaining the physiological working of the lung during the operation, the other one working without apparatus, I say, I feel sure, that the one who used the differential pressure method would get a higher percentage of recoveries than the one who did not use it.

2. **Avoidance of the Acute Postoperative Pneumothorax and of the Accumulation of the Pleural Exudate by Means of Air-Tight Thoracic Drainage.** In my endeavors to drain the chest and, incidentally, to avoid the occurrence of the acute postoperative pneumothorax I have at last decided upon a method of choice. It is an adaptation to general operative work of the method of air-tight drainage used by Dr. Kenyon, of New York City, in the treatment of empyema in children, and practised in a similar way, for the treatment of the same disease in patients of any age, by Buelau, more than twenty-five years ago. I consider it a universally useful method for draining the chest air-tight, after any and every kind of intrathoracic work. To keep the patient with free (not air-tight), thoracic drainage under the influence of differential pressure within the apparatus, negative chamber or positive cabinet, as worked out at our hospital six or seven years ago, is also an excellent method, but it is cumbersome.

Of another evidently useful method, Tiegel's metal drain, with valve arrangement at its outer end, I have no personal experience.

Today, before closing the chest incision completely by layer sutures, we make a stab one or two interspaces lower in the posterior axillary line, introduce in air-tight fashion a rubber tube about as large as the third finger of a man, the tube having one or more side holes near its inner end and outside a short glass tube interposed, fasten it securely with broad adhesive plaster strips and let its free end dip into a graduated siphon bottle, which is partially filled with sterile water or some kind of antiseptic solution. Our observations and results have shown this to be a splendid and reliable method for accomplishing our purposes. One can see in the glass tube the quality of the secretion and measure in the siphon the quantity discharged within a given period. At the same time this method thoroughly and safely fulfils the demand made by those most experienced in thoracic surgery: to always close the chest air-tight in order to allow the lung to expand at once.

The two principles underlying the safe and more rapid evolution of thoracic surgery, as I see them, then, are:

1. The use of the differential pressure method in order to avoid the occurrence of an acute pneumothorax during operation.

2. The immediate and complete closure of the incision in conjunction with air-tight thoracic drainage after every case of thoracic operation in order to avoid the acute postoperative pneumothorax as well as the accumulation of exuding fluid within the pleural sac.

(A series of lantern slides then illustrated the points previously discussed.)

SURGICAL TREATMENT OF PLEURISY.*

By J. L. Yates, M.D.,
MILWAUKEE, WIS.

Progress in the operative treatment of pleuritic effusions has until recently, been impeded by the concentration of surgical attention upon the curative therapy of empyema. This is an important part of the problem, but only a part, as purulent pleurisy is merely the late stage of some of these affections. The first therapeutic advance, made about five centuries B.C., was the conversion of a closed into an open pyothorax to start drainage. The second notable step forward, taken some twenty-four centuries later, was the conversion of an open pyothorax into a closed thorax to stop drainage. A third line of progress, starting with this latter period, has developed a method of air-tight drainage whereby both prophylactic and curative measures can find their simplest application.

Open thoracic drainage was introduced by Hippocrates, who recognized that simple acute, fetid or chronic empyema could be idiopathic, traumatic, postpneumonic or precede or follow phthisis. He learned that the drain should be placed low and that open drainage should neither be established too early nor be permitted to proceed too rapidly. Twenty-four hundred years' experience and observation have added very little to these teachings.

Closure of an open pyothorax has always been a serious problem because a proportion of individuals fail to heal spontaneously after thoracostomy. No doubt Hippocrates was confronted with the identical dilemma of a death from amyloid disease, an operative failure or considerable physical and functional disability. There are but three ways healing can be fostered under these conditions: (1) By collapsing the thoracic parietes against the retracted lung through some form of costoplasty, a method with which the names of Estlander and Schede are associated; (2) by releasing the adhesions surrounding the collapsed lung, the principle of decortication of Delorme and thereafter expanding the lung to meet the parietes; (3) by obliterating the intrapleural space with tissue transplants or

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